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SOLDERING SYSTEM FOR TAB LEADS
[TABURIDONO HANDAZUKE SOCHI]

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[Claims] /*

[Claim 1] The soldering system for tab leads comprises a supply stage for feeding solar cells and tab leads, a connecting stage for connecting the solar cell and the tab leads electrically, a transport mechanism for carrying the solar cell and the tab leads from the supply stage to the connection stage, and a holding mechanism for holding the solar cell and the tab leads being carried by the transport mechanism.

[Claim 2] The soldering system for tab leads according to Claim 1, wherein said holding mechanism has a holding member which moves in a synchronized manner with the solar cell being transported by said transport mechanism while holding said tab leads.

[Claim 3] The soldering system for tab leads according to Claim 1 or Claim 2, wherein said connecting stage is equipped with a preheater that preheats the solder, a main heater that heats the solder to melting temperature, and a pusher that pushes the tab leads against the solar cell.

[Detailed Description of the Invention]

[0001] [Technical Field of the Invention]

This invention relates to a soldering system for soldering tab leads on solar cell that is suitable for manufacturing process of solar cells.

[0002] [Prior art]

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* Claim and paragraph number correspond to those in the foreign text.

Recently, various development attempts have been made regarding solar cells in order to utilize solar energy. Various forms of proposed solar cells include crystal type solar cells using single crystal silicon or polycrystalline silicon, amorphous type solar cells using amorphous silicon, and others.

[0003] Production of such solar cells involves a process which forms a string by electrically connecting multiple solar cells, which convert solar energy into electric energy, via tab leads; and a process which laminates this string after inserting it between a transparent cover and a protective material. Conventionally, soldering equipment used in soldering of such solar cells was structured so that tab leads are pressed by a pin against the surface electrode of the solar cell being held by a jig on a stage, and solder inserted between the tab leads and the surface electrode of the solar cell is melted by heating it with a heater.

[0004] [Problems to be Solved by the Invention]

However, with such conventional soldering equipment, both the process to position the tab leads on the surface electrode of the solar cell as well as the process to heat the solder to apply the tab leads to the surface electrode of the solar cell were conducted on the same stage. For this reason, the soldering process with one solar cell had to be completed before the next solar cell can be transported to the stage. Therefore, the soldering process used to take up too much time and the productivity was difficult to improve.

[0005] In the meantime, in order to improve efficiency, some systems were proposed which provided multiple stages to carry out the positioning of the tab leads, heating, and application at each stage in parallel. However, this required that such devices for positioning the tab leads, heating, and applying be provided separately for each stage. This made the soldering equipment costly and large, which caused the production costs of solar cells to rise.

[0006] Thus, the objective of this invention is to provide a small and inexpensive system for soldering tab leads efficiently while positioning them accurately against the surface electrode of the solar cell.

[0007] [Means for Solving the Problems]

In order to achieve this objective, Claim 1 of this invention provides a soldering system for tab leads comprising a supply stage for feeding a solar cell and tab leads, a connecting stage for connecting the solar cell and the tab leads electrically, a transport mechanism for carrying the solar cell and the tab leads from the supply stage to the connection stage, and a holding mechanism for holding the solar cell and the tab leads being carried by the transport mechanism.

[0008] Under the soldering equipment of this Claim 1, a solar cell and tab leads are provided at the supply stage. In this case, the solar cell and the tab leads could be provided to the supply stage after positioning them, or the solar cell and the tab leads

could be positioned at the supply stage. And these solar cells and tab leads are transported from the supply stage to the connection stage by the transport mechanism. During the transport by the transport mechanism, the solar cell and the tab leads are held by the holding mechanism. And the tab leads are electrically connected to the solar cell on the connection stage.

[0009] Since this soldering system under Claim 1 provides a supply stage and a connection stage separately, it is possible to conduct feeding and positioning of the solar cell and tab leads at the supply stage while conducting electric connection of the tab leads to the solar cell on the connection stage. This enables parallel execution of each of these two different processes on the supply stage and the connection stage at the same time. Further, since the solar cell and tab leads are held by the holding mechanism during transportation from the supply stage to the connection stage, there is no danger of displacement of the tab leads and the solar cell off the intended position. The soldering system under Claim 1 does not require the heating mechanism and the applying mechanism on the supply stage and does not require the positioning mechanism for tab lead on the connection stage. Thus, it is possible to reduce the size and the cost of the soldering system, which keeps the production cost of the solar cells low. Further, since it is possible to conduct the supplying and positioning of the solar cells and electrically connecting the tab lead in parallel, the string can be produced

efficiently and continuously.

[0010] As was stated in Claim 2, with the soldering system for tab lead according to Claim 1, said holding mechanism can also have a holding member which moves in synchronized manner with the solar cell being transported by said transport mechanism while holding said tab leads.

[0011] Under the soldering system according to Claim 2, it is possible to hold the tab leads with the holding member while transporting the solar cell and tab leads from the supply stage to the connection stage. Thus, there is no risk for the tab leads to be displaced during transporting them with the transport mechanism.

[0012] Further, as stated under Claim 3, it is also possible to provide a preheater for preheating solder, a main heater for heating solder to the melting point, and a pusher for pressing the tab leads against the solar cell.

[0013] Under this soldering system according to Claim 3, at the connection stage, solder is first preheated by the preheater, and it is further heated by the main heater to the melting temperature. Further, by pressing the tab leads by the pusher against the solar cell, the tab leads are electrically connected to the solar cell.

[0014] [Embodiment]

Next, details of an embodiment of this invention are explained using illustrating figures. Figure 1 is a perspective view showing overall schematics of the soldering system 1 relating to an

embodiment of this invention.

[0015] This soldering system 1 is equipped with a conveyor 10 as a transport mechanism that transports the solar cell c and the tab leads t to the right direction in the figure. A supply stage 11, to which the tab leads t and the solar cell c are supplied after positioning, is provided at the lead position of the conveyor 10 (at the left edge location of the conveyor 10 in Figure 1), and a connection stage 12, which electrically connects the tab leads t to the solar cell c, is provided on the downstream side of the transport direction of the conveyor 10 (further right of the supply stage 11 in Figure 1). Further, in this embodiment, a transport stage 13, which takes out the produced string s after completion of soldering by the soldering system 1, is provided on the downstream side of the connection stage 12 in the transport direction of the conveyor 10 (to the right of the connection stage 12 in Figure 1).

[0016] On the side of the conveyor 10 (in front of the conveyor 10 in Figure 1) are a tab lead supply mechanism 15 which supplies tab leads t, a solar cell supply mechanism 16 for supplying solar cells c, and a string cassette 17 for stocking the strings s produced by this soldering system 1. The string cassette 17 is placed on the transport stage 13 side (in front of the transport stage 13 in Figure 13). Also, as explained later, produced strings after completing the soldering by the soldering system 1 are taken up from the conveyor 10 by the transport mechanism on the transport stage 13 and are handed

over to the string cassette 17.

[0017] The solar cell supply mechanism 16 has cameras 20, 21 and a pair of flux coating rollers 22. And each one of many of solar cells stored in an appropriate container (a carrier cassette, for example) is taken out one at a time and transported. Each solar cell c is inspected with a camera 20 for defects such as a crack while being transported. After the solar cell is positioned by a camera 21, flux 23 is coated on the surface of the solar cell to obtain good soldering. If a defect is detected by the camera 20, such solar cell c' is expelled by a removal mechanism (not shown) to a side (to the front in Figure 1).

[0018] The tab lead supply mechanism 15 is equipped with a pair of rolls 25 with tab lead t wrapped around it, and a pair of cutters 26. Solder is coated on the surface of the tab lead t. Tab lead t continuously rolled out from the roll 25 is cut to appropriate length by the cutter 26, and, in the example shown, two of the cut tab leads t are positioned at prescribed locations. In this manner, when the tab leads t are positioned on the surface of the solar cell c, the flux 23, which was coated by previously mentioned flux coating roller 22, is inserted between the tab lead t and the solar cell c.

[0019] Further, by a transport mechanism equipped with a suction pad, etc., solar cell c with a tab lead t positioned on its surface is placed on the conveyor 10 at the supply stage 11.

[0020] The conveyor 10 goes around a drive roller 30 and the

other three driven rollers 31, 32, and 33. Intermittent rotary power (rotary power in clockwise direction in the example shown) from a motor 35, such as a servo motor for example, is transmitted to the drive roller 30 via a shaft 36. When the motor 35 is activated, the conveyor 10 rotates intermittently in the clockwise direction in the figure. With this, the solar cell c placed on the conveyor 10 at the supply stage 11 is moved intermittently from the connection stage 12 to the transport stage 13, in that order.

[0021] As shown in Figure 2, multiple air intake holes 40 are provided on the surface of the conveyor 10. The solar cell c placed on the conveyor 10 at the supply stage 11 is sucked onto the conveyor 10 by sucking air through the air intake holes 40 as the air supply chamber 31 placed in the inside of the conveyor decreases the air pressure. With this structure, the solar cell c is suction-held while it is being transported from the supply stage 11, the connection stage 12, and the transport stage 13, in that order.

[0022] Both Figures 3 (a) and (b) show the solar cell c and tab leads t, seen from above, which were placed on the conveyor 10 at the supply stage 11. First, as shown in Figure 3(a), a solar cell c1, with tab leads t1 positioned on its surface, is supplied on the conveyor 10 at the supply stage 11. Namely, under this embodiment, two tab leads t1 are placed against one solar cell c1. Both of these two tab leads t1 are placed so that they protrude from the top of the solar cell c1 toward the upstream of the transport direction of the

conveyor 10 (to the left of the solar cell c1 in Figure 3(a)). With this, these are positioned so that the tip side of the two tab leads t1 (to the right of the tab lead t1 in Figure 3(a)) comes in contact with the surface electrode (not shown) on the top surface of the solar cell c1. When the solar cell c1 and the tab leads t1 are supplied, the conveyor 10 is stationary.

[0023] Next, after the tab leads t1 and the solar cell c1 are positioned on the conveyor 10 at the supply stage 11, the tab leads t1 and the solar cell c1 are moved by intermittent movement of the conveyor 10, and the conveyor 10 is configured to come to a stop again after that. Further, after this conveyor 10 is stopped again, as shown in Figure 3(b), the next solar cell c2, with two tab leads t2 positioned on its surface as before, are supplied onto the conveyor 10 at the supply stage 11. When the next solar cell c2 is supplied in this manner, it is placed so that the tip side of the solar cell c2 (right side of the solar cell c2 in Figure 3(b)) would sit on the trail side (left side of the tab lead t1 in Figure 3(b)) of the tab leads t1 which are protruding from the solar cell c1 to the upstream side (left side of the solar cell c1 in Figure 3(b)) in the transport direction of the conveyor 10. With this, the solar cell c2 is positioned so that its bottom electrode (not shown) on its bottom surface would touch the tail side of the two tab leads t1 (left side of the tab lead in Figure 3(b)).

[0024] By repeating the process explained in Figure 3(a) and

(b), a prescribed number of solar cells c and tab leads t are placed one after another on the conveyor 10 at the supply stage 11. These are supplied with the tab leads t positioned so that they come in contact with the solar cell c between the surface electrode and the bottom electrode. For supplying each of these solar cells c and tab leads t at the supply stage 11, a transport mechanism (not shown) equipped with suction pad and the like is used.

[0025] Next, as shown in Figure 1, a holding mechanism 50 is provided on top of the conveyor 10 that can maintain the positioning, which keeps the tab leads t in contact with the top electrode and the bottom electrode of the solar cell c, while being transported from the supply stage 11 to the connection stage 12. This holding mechanism 50 comprises continuous belt 55 that wraps around the drive roller 51 and three driven rollers 52, 53, and 54; and multiple press rods 56 mounted around this continuous belt at a prescribed interval. The continuous belt 55 is placed above and to the side of the conveyor 10 (behind the supply stage 11 and the connection stage 12 in Figure 1), with the tip of the press rods 56 protruding to the side of the continuous belt 55 (to the front of the continuous belt 55 in Figure 1) placed above the conveyor 10. The intermittent rotary power from above-mentioned motor 35 is transmitted to the drive roller 51 via a shaft 36, gears 60, 61, shaft 62, timing pulley 63, timing belt 64, timing pulley 65, and shaft 66. The drive roller 51 revolves in counterclockwise direction (counterclockwise in the

example shown) at the same speed, and at the same timing, as with the drive roller 30 of the conveyor 10. With this, the continuous belt 55 revolves intermittently in the counterclockwise direction in the figure at the same speed and at the same timing as the conveyor 10. Thus, the press rods 56 travel, while facing the top surface of the conveyor 10, in the same direction as the top surface of the conveyor 10 (to the right in Figure 1) and at the same speed intermittently.

[0026] As shown in Figures 4 and 5, in the holding mechanism 50, each of these press rods is supported by support member 70 fixed on the outer perimeter of the continuous belt 55 at a prescribed interval. Further, two of holding members 72 are provided, via spring members 71, at the tip end of press rods protruding to the side of the continuous belt 55 above the conveyor 10. The holding member 72 is structured so that both ends of metallic wire material in a rough U-shape are mounted on the spring member 71. By applying rotary force of the holding member 72 with the elastic force of the spring member 71 downward, the holding member 72 presses on and holds two tab leads t positioned on the surface of the solar cell c placed on the conveyor 10.

[0027] Further, as was explained before, while the tab leads t are held on the top surface of the solar cell c by the holding member 72, the press rods 56 travels intermittently in the same direction at the same speed with the top surface of the conveyor 10 with the revolving continuous belt 55. This configuration allows

transportation of the solar cells c and tab leads t placed on the conveyor 10 to travel from the supply stage 11 to the connection stage 12 without losing their positions.

[0028] Next, as shown in Figure 1, at the connection stage 12, a preheater 80, a main heater 81, and a pusher 82 are provided above the conveyor 10. As shown in Figure 6, the preheater 80 and the main heater 81 are equipped with lamp heaters 85 and 86. And the pusher 82 is equipped with a pusher rod 87. Additionally, the solar cells c and tab leads t, placed on the conveyor at the supply stage 11, are moved sequentially by the intermittent movement of the conveyor 10 explained earlier to below the preheater 80, main heater 81, and pusher 82. When the solar cell c and tab leads t are transported to the connection stage 12 by the movement of the conveyor 10, the solder coated on the surface of the tab leads is preheated by irradiation of the lamp heater 85 at the preheater 80. Then, the solder coated on the surface of the tab leads t is melted by irradiation of the lamp heater 86 at the main heater 81. Further, as the pusher rod 87 descends at the pusher 82, the lower end of the pusher rod 87 presses the tab lead t against the solar cell c. Further, while the solar cell c and tab leads t are moved sequentially below the preheater 80, the main heater 81, and the pusher 82 as they are transported by the conveyor 10, the tab leads t placed on the solar cell c are held by the holding member 72, which prevents the positioned parts to be disturbed.

[0029] With this soldering system 1 configured as above under the embodiment of this invention, two tab leads t supplied from the tab lead supply mechanism 15 are placed against each of solar cell c fed from the solar cell supply mechanism 16. And, by a transport mechanism (not shown), solar cell c with tab leads t positioned on its surface is placed on the conveyor 10 at the supply stage 11.

[0030] Next, the solar cell c placed in this manner on the conveyor 10 is moved, by intermittent rotation of the conveyor 10, from the supply stage 11 to the connection stage 12 and to the transport stage 13 in that order. During this traveling, the solar cell c is suction-held on the conveyor 10, and two tab leads t placed on the solar cell c are held by being pressed down by the holding member 72. This would prevent the solar cell c and tab leads t from being displaced out of position.

[0031] And at the connection stage 12, the solder coated on the surface of the tab leads t are preheated first by the preheater 80. Next, the solder coated on the surface of the tab leads t are melted by the main heater 81. Further, the tab leads t are pressed down on the solar cell c by the pusher 82. In this manner, the tab leads t are electrically connected to the solar cell c at the connection stage.

[0032] Then, these strings manufactured by electrically connecting the tab leads t to the solar cell c at the connection stage 12 are taken out to the transport stage 13. Then, these

manufactured strings s are taken up by a take-up mechanism (not shown) from the conveyor 10 at the take up stage 12, and are handed over to the string cassette 17 one after another.

[0033] With the soldering system 1 under this embodiment, it is possible to conduct two different processes in parallel at two stages 11 and 12. Namely, it is possible to supply and position the solar cell c and tab leads t at the supply stage 11, and to electrically connect the tab leads t to the solar cell c at the connection stage 12. Also, since the supply stage does not require a heating mechanism and applying mechanism, and the connection stage 12 does not need to have a positioning mechanism of the tab leads t, it is possible to provide the soldering system 1 having a small size and low cost, which also lowers the manufacturing costs of the solar cells. Further, since it is possible to conduct the supplying and positioning of the solar cells c and the tab leads t, and to electrically connect the solar cell c and the tab leads t in parallel, the strings can be produced efficiently and continuously. Further, during transporting from the supply stage 11 to the connection stage 12, the solar cell c is suction-held on the conveyor 10, and two tab leads t placed on the solar cell c are held by being pressed down by the holding member 72. This would prevent the solar cell c and the tab leads t from being displaced out of position.

[0034] The above is the explanation of one favorable embodiment of this invention. However, this invention is in no way limited by

the above-described embodiment, and it can be appropriately modified and applied as needed. For example, in the example above, the solar cell c and the tab leads t were positioned ahead of time and then supplied to the supply stage 11. However, it is possible to configure the system so that the solar cell c and the tab leads t are positioned at the supply stage 11.

[0035] Further, it is also possible for the preheater 80 and the main heater 81 to use hot air for heating. The lamp heaters 85 and 86 provided in the preheater 80 and main heater 81 could use any one of the far-infrared ray, near-infrared ray, or middle-infrared ray. Further, ceramic heaters could be used instead of lamp heaters 85 and 86. There is no restriction on the number of the preheaters 80 and the main heaters to be used, either. It is possible to use two or more units. It is possible also to omit the preheater 80. The heating temperature of the preheater 80 and the main heater 81 could be set freely. It could be appropriately set according to the type of device to be heated (such as solar cell c), solder, and flux.

[0036] Incidentally, since the solar cell c is heated by the preheater 80 and the main heater 81 while the solar cell c is on the conveyor 10, if the conveyor 10 is made from steel belt, for example, the top surface of the conveyor 10 could warp and be deformed as the steel belt is heated. If the surface of the conveyor 10 should warp, the solar cell c would become unstable on the conveyor 10 and could cause problems with positioning and soldering. In order to prevent

such deformation of the conveyor 10, it is better to make the drive roller 30, and the driven rollers 31, 32, and 33 in middle-high (crown) shape. Also, it is possible to prevent the deformation of the conveyor 10 by providing tension controllers in part of, or over the entire, drive roller 30, and the driven rollers 31, 32, and 33. Also, it is possible to suppress warping of the conveyor 10 by applying suction force from below the conveyor 10 or press the conveyor 10 from below in the connection stage 12 comprising the preheater 80, the main heater 81, and the pusher 82.

[0037] Further, in order to prevent deformation of the conveyor 10, it is possible to make up the conveyor from multiple (three in the example shown) belts 90, 91, and 92. In this case, the belts 90 and 92 on both sides should be placed below the tab leads t positioned on the solar cell c, while the belt 91 in the middle should support around the center of the solar cell c.

[0038] Further, it is possible to adopt a configuration in which the tab leads t are pressed against the solar cell c by the pusher 82 while they are being cooled by a blower and the like. Since the solar cell c is normally made from materials such as silicon with excellent heat conductivity, it is possible to heat the back and the front side of the solar cell c simultaneously with the preheater 80 and the main heater 81. Thus, it is possible to solder the tab leads t to the back and the front of the solar cell c at the same time. However, it is also acceptable to provide heaters on the lower side of the conveyor

10 opposite the preheater 80 and the main heater 81. In this case the heaters placed below the conveyor 10 could be hot plates, for example. Further, it is possible to omit pusher 82 if the tab leads t on the surface of the solar cell c are held by a holding member while it is transported as with the system under the embodiment.

[0039] Further, the shape of the solar cell c is not limited to a quadrangle, and could be circular or SUKURANDO, or another polygon. Further, it is possible to connect one tab lead or three or more tab leads t to one solar cell c. The transport by the conveyor 10 is not limited to intermittent mode and could be continuous. Further, the holding mechanism 50 could provide one or three or more holding members 72 at the tip section of the press rod 56.

[0040] [Advantageous Effects of the Invention]

With the soldering system of this invention, it is possible to perform different processes in parallel at the supply stage and the connection stage, which allows efficient and continuous production of strings. Also, since the supply stage does not require a heating mechanism and applying mechanism, and the connection stage does not need to have a positioning mechanism of the tab leads t, it is possible to provide the soldering system having a small size and low cost, which also lowers the manufacturing costs of the solar cells. Further, since the solar cell and the tab leads are held by the holding mechanism during transportation from the supply stage to the connection stage, there is no danger of displacement of the tab leads

and the solar cell off the intended position.

[Brief Description of Drawings]

[Figure 1] This is a perspective view showing the overall schematics of the soldering system relating to an embodiment of this invention.

[Figure 2] This is a partial magnification of the conveyor.

[Figure 3] (a) is a top view showing the first solar cell and tab leads placed on the conveyor at the supply stage; (b) is a top view showing the next solar cell and tab leads placed on the conveyor at the supply stage.

[Figure 4] This is a side view of holding mechanism.

[Figure 5] A cross-sectional view at A-A in Figure 4.

[Figure 6] This illustrates the preheater, the main heater, and the pusher provided on the connection stage.

[Figure 7] This illustrates the conveyor divided into multiple parts.

[Figure 8] This illustrates the belt placed below the tab lead and the center of the solar cell.

[Description of Codes]

c ... Solar cell;

t ... Tab lead;

1 ... Soldering system;

10 ... Conveyor;

11 ... Supply stage;

12 ... Connection stage;

50 ... Holding mechanism;

55 ... Continuous belt;

56 ... Press rod;

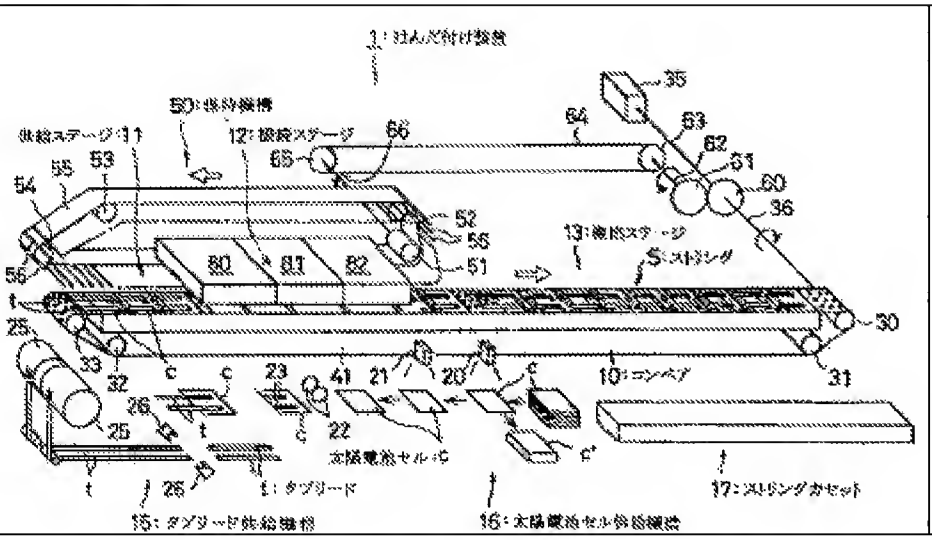
72 ... Holding member;

80 ... Preheater;

81 ... Main heater;

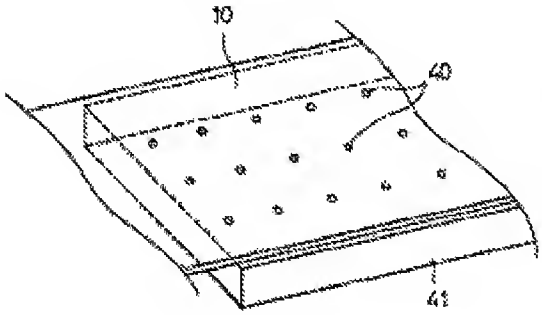
82 ... Pusher.

[Figure 1]

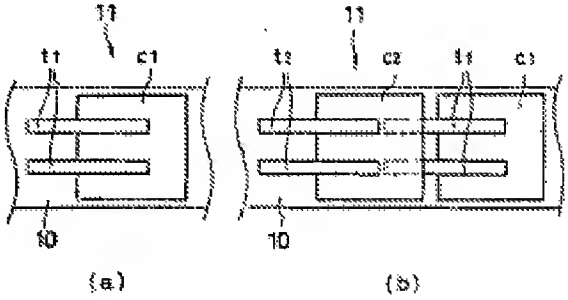


13- Transport stage
S- String
15- Tab lead supply mechanism
16- Solar cell supply mechanism
17- String cassette

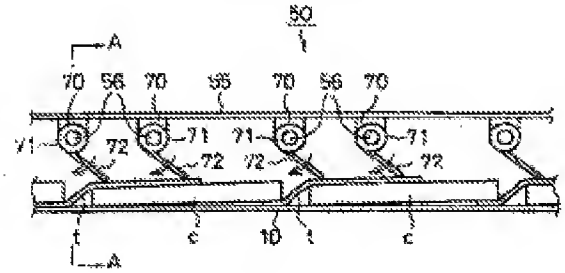
[Figure 2]



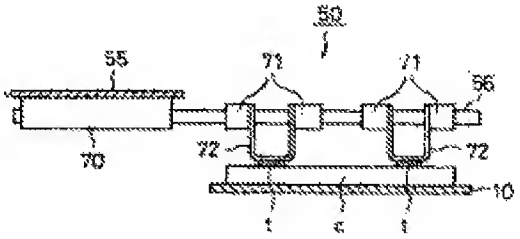
[Figure 3]



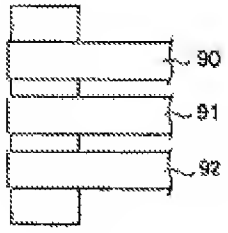
[Figure 4]



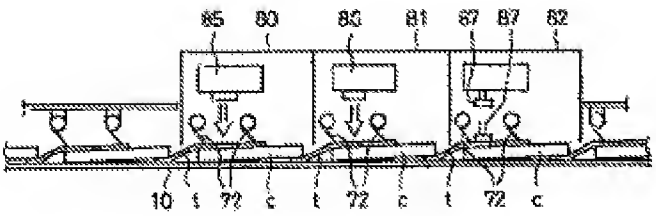
[Figure 5]



[Figure 7]



[Figure 6]



[Figure 8]